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ELECTRICITY IN GYNECOLOGY:

THE GALVANIC APPARATUS.

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The past few years have seen electricity taken from the hands of the charlatans and elevated to a high standing as a therapeutic agent by the labors of the regular profession. At first, generally avoided by reputable men, because of the odor of quackery hanging about it, electricity was slow in gaining a foothold and demanding a recognition of its merits in combating disease. Being, at first, used in an empirical manner, it gained the confidence of the profession slowly, but fortunately a number of its enthusiastic supporters proved by investigation and trial, that, in certain fields of medicine electricity could be used in a rational, as opposed to an empirical manner, and that its action was direct and positive. Beard, Rockwell and Bartholow have been, perhaps, the foremost in this country in placing this agent in its proper light before the profession. Its value as a diagnostic and therapeutic aid in nervous diseases is now recognized and admitted by all, as is also its wide range of usefulness in many general diseases, especially those of a chronic nature.

The use of electricity in the diseases of women has been prominently brought forward by Apostoli and his followers, who, while making claims for this agent which at first seem almost improbable, are not only able to verify their claims by the results obtained by themselves, but also to so simplify the methods of using electricity as to make it possible for any one possessed of ordinary ingenuity and skill to also verify them.

Apostoli, while using electricity in the treatment of uterine fibroids, noticed that the intra-uterine pole, having a caustic action, relieved the chronic inflammatory diseases of the uterus and that an inter-polar effect was produced upon inflammatory thickenings and deposits in and around the uterine appendages. This naturally led him to make use of the electrical current, in an experimental way, in the many affections peculiar to the female generative apparatus, and as a result of his labors, we have placed in our hands a new agent for the treatment of many of these obstinate diseases. An agent which will produce an absolute or a relative cure in conditions where formerly it was necessary to resort to the knife, and one which will more quickly produce a cure in those innumerable diseases which have formerly been treated by the application of astringents, caustics and so-called alteratives.

Conservative advocates of electricity do not claim that it will cure all diseases to which female human flesh is heir, nor do they expect that it will supplant all other means of treatment in these troubles. Here lies the greatest danger to electricity, in that many electrical enthusiasts are claiming and will continue to claim too much for this agent. Many are apt to be led into error by these extravagant claims, and, after fair trial, failing to realize their too high expectations, condemn the treatment as worthless. There are certain diseased conditions which electricity will relieve more thoroughly and quickly than any other treatment now employed, but it will not be successful in all. It will at times fail to cure just as other remedies fail. Because it is successful in some cases it should not be

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used in all diseases to the exclusion of other means. It is simply a new remedy added to those already in use in gynecology.

Treatment by electricity should not be known as the electrical method any more than the application of iodine should be known as the iodine method.

Electricity has its bitter detractors as well as its enthusiastic advocates, but these are extremists, who, sooner or later, must recede from their extreme positions and give electricity the credit which it proves to merit, but neither more nor less.

Before proceeding to describe the manner of treating the diseases of women by electricity it will be necessary to give a description of the apparatus needed to generate, control, measure and disperse the current, as the old fashioned methods of handling electricity must give way to exact scientific methods.

In the selection of the cells forming a galvanic battery great care should be used to select the best from among the large number now in the market. The requirements of a good cell are long lived elements, widely varying potential of its elements, giving a high electro-motive force, low internal resistance, slow polarization, rapid depolarization and ability to do a maximum amount of work with a minimum amount of attention.

A cell consists of two elements partially immersed in an exciting fluid. Electricity is generated by the action of the fluid upon one of the elements. The element so acted upon is called the generating plate. The electricity thus generated collects upon the other plate which is called the collecting plate. The fluid also acts upon the collecting plate to a greater or less extent, depending upon the substance of which the plate is composed. The less the action of the fluid upon the collecting plate, as compared with its action upon the generating plate, the greater the propelling or motive force of the cell. This partially explains what is known as "potential." To further explain the subject of potential it is necessary to refer to an old experiment in physics, showing how two connecting bodies of water seek a level. If two perpendicular tubes are filled with water to an unequal height and are then connected at the base the water in both tubes seeks a common level. The greater the height of water in one tube as compared with that in the other, the greater is the force produced in bringing the two columns to a level. There is, of course, a resisting force in the lower column pressing in an opposite direction to the force in the higher column. These two forces can be called the potential of the two columns. In a cell, the two elements, being acted upon unequally by the fluid, produce two forces of unequal intensity which seek a level. The force produced at each element is the potential of that element, and the greater the difference between the potential of the two elements the greater the force, known as the electro-motive force, produced. The two elements having the greatest difference of potential are zinc and carbon. A cell, then, having zinc and carbon elements answers the requirements of a good cell in having elements of widely varying potential, giving a high electro-motive force. It also has long lived elements as the carbon is practically indestructable. The zinc is, of course, destroyed, the rapidity of destruction depending upon the amount of usage and the nature of the fluid in which it is immersed. If the immersing fluid is of dilute sulphuric acid, as in the bi-chromate of potash cell, the destruction of the zinc is much more rapid than if the fluid is a solution of sal ammoniac. However, with the greater destruction of the zinc in the acid cell a higher electro-motive force is produced than in the sal ammoniac cell.

The electro-motive force of a battery does not depend upon the size of its cells and their elements but upon the number of them. A small cell produces as great *intensity* as a large one A small cell, however, does not produce as great *quantity* as a large one, so that

it is necessary to select large cells in order to obtain quantity and to sufficiently increase their number to obtain the desired intensity.

When a cell is in action hydrogen is set free, by decomposition of the water, and the bubbles of hydrogen form a film over the collecting plate. When the collecting plate becomes covered with the film of hydrogen the cell is said to be polarized and no current can be derived from it, as the current produced in the cell passes back and forth between the hydrogen, which then becomes a generating plate, and the zinc. Naturally, a large collecting plate will not become covered with hydrogen as quickly as a small one and consequently will not polarize as rapidly. In the selection of a cell, then, look for one with a large carbon or collecting plate. The cell requiring least attention is one of zinc and carbon elements immersed in a solution of sal ammoniac. The cell best adapted for a stationary battery is, undoubtedly, the Law cell, having, as it does, zinc and carbon elements, the carbon being arranged in the form of a double cylinder, giving a large collecting plate, being slow in polarizing and rapid in depolarizing. There are several other cells, with zinc and carbon elements, made somewhat after the plan of the Law cell, which are quite satisfactory. The Diamond Carbon cell of McIntosh has the carbon arranged in the form of rods, seven in number, which are suspended in a circle, in the center of which is placed the zinc rod. The Laclede and the Holtzer cells have a single carbon cylinder with the zinc rod in the center. Probably, no cell has enjoyed a reputation for open circuit work equal to that of the Leclanchè, but, although its first cost is comparatively low, it is ultimately an expensive cell, as after two or three years of ordinarily constant use its negative element, contained in the porous cup, becomes useless and must be replaced by a new element, costing nearly as much as the original cell. As the zinc and fluid are also perishable the time soon comes when nothing useful is left of the cell except the glass jar.

For portable batteries zinc and carbon elements immersed in a dilute solution of sulphuric acid, containing bichromate of potash to delay polarization, are the best. The greatest drawback to these portable batteries is the constant care which they require. The chloride of silver batteries, while they are clean and require practically no care, are not satisfactory where high ranges of current are necessary.

In connecting up the cells of a battery they should be so arranged as to give great intensity, or electro-motive force, in order to send the current through the resistance offered by the patient's body, as Ohm's law states that the current strength is equal to the electromotive force divided by the resistance. In order to obtain the greatest electromotive force possible from the battery the cells must be arranged in series. That is, the carbon of the first cell must be connected with the zinc of the second, the carbon of the second with the zinc of the third, and so on to the last. The circuit is then closed by leading a wire from the zinc of the first cell, and one from the carbon of the last cell to the patient.

In order to collect the current from the cells and bring it to the electrodes various forms of switch-boards were formerly employed. The oldest and simplest form consists of a crank, the free extremity of which travels over a circle of pegs, each peg being connected with a cell from the battery. The current is increased cell by cell, as the crank is passed from peg to peg. This form of switch-board is decidedly unsatisfactory, as every time the battery is used the first few cells in the series are in action, while the higher numbered cells are seldom used, they being called into action only when the whole current strength is being utilized. As a result of this unequal use a few cells soon become weakened or have their destructable parts used up completely while others remain active and uninjured. If, from any cause, one of the

lower numbered cells should fail to work none of the higher numbered ones could be used until the defective cell had been repaired or replaced by a new one.

To overcome these defects an improved switch-board, having two arms or cranks, called a compound switch, has been constructed. By its use any number of cells, either at the beginning or end of the series, can be brought into, or cut out of, the circuit. By means of the compound switch all of the cells can be used equally, if care be used, and any defective cell can be cut out of the circuit and the cells on either side of it used.

One objection, which applies to the compound as well as to the single switch, is the great number of wires required to connect the board with the cells. One wire must be led from every cell to the board and one extra wire to complete the circuit, so that in using a battery of fifty cells fifty-one wires are necessary. This means fifty-one opportunities for breaking the current. When more cells are used than there are pegs in the switch-board two or more cells must be connected to one peg, and as all the cells which are connected to one peg are brought into the circuit at once, the current strength is suddenly increased, which should, under no circumstances, ever be done in gynecological work. In gynecology these switch-boards should not be used, but in their place a collector or controller which will allow the current strength to be increased in a very gradual and steady manner. There are two forms of current controller which will do this, and one of these forms, or some modification of them, should be used invariably.

One of these, and the one which will probably give the best satisfaction with the least amount of care, is the Bailey current regulator or controller. It consists of a tall glass jar in which are suspended four carbon plates, the lower extremities of which taper to points which are tipped with sponge. The plates are arranged in pairs, the two pair being carefully insulated from one another. Each pair of plates is provided with a binding post, to which the wire going to and coming from the controller are attached. The plates are raised and lowered in the jar by means of a milled wheel operating a rack and pinion. For use the controller is partially filled with water and as the plates are gradually lowered into it the circuit is closed, the current passing from one pair of plates, through the water, to the other plates, and thus to the patient. When the tips of the plates just touch the water a very small quantity of electricity can pass, but as the plates are gradually immersed so is the current strength gradually increased.

The other form of controller is known as Massey's, and consists of a ground glass or porcelain plate covered with graphite in varying thicknesses, which acts as a resisting medium, over which a crank, provided with a contact point moves. The McIntosh Battery Co. manufacture a controller similar to the Bailey, but in which the carbon plates are replaced by thin sheets of platinum.

In the use of these controllers but two wires are necessary to connect the whole battery with the dispersing binding posts. The cells are to be connected in series and a wire from the zinc of the first cell is carried to the negative binding post, to which a conducting cord leading to the patient is attached. The other wire is carried from the carbon of the last cell to the controller, from which a wire extends to the positive binding post by way of the meter.

In this way a battery composed of fifty cells has but two wires, as compared with fifty-one where a switch-board is used, so that the risks of current breakage are greatly diminished. By the use of the controller all of the cells are worked uniformly and no one will give out until all do so.

Until recently no attempt was made to accurately measure the strength of the galvanic current, administered in a given case, so that no exact rules could be laid down as to dosage. One person could not derive much benefit from the investigations of another, or even from

his own investigations, as it was almost impossible to give the same dose of electricity in two different cases, or even in the same case at different times. The only manner in which it was possible to report the approximate dose was by stating the number of cells in action. This, for several reasons, was found to be a decidedly erroneous method. The electro-motive force in different cells widely varies, and even in the same cell it is not constant owing to deteriorating elements and solution. Then, we have seen, the current strength is equal to the electro-motive force divided by the resistance, and even if the electro-motive force in all cells was the same and remained constant, the current strength, passing through the patient, would vary with the patient's resistance, which ranges from a few to several thousand ohms. The size of the electrodes, the amount of water they contain and the degree of firmness with which they are pressed against the patient, all influence the quantity of electricity which will pass between them.

Therefore, an exact method of measuring the current strength was imperatively demanded. This demand was met by the construction of the milliampere meter, which consists of a galvanometer graduated in the thousandths of an ampere, or milliamperes. In the construction of the galvanometer advantage was taken of Oersted's discovery that a magnetic needle, suspended near a wire over which a current of electricity was passing, would be deflected from its natural position. In the galvanometer a needle is suspended in the center of a coil of wire, and when a current is passed through the wire the needle is deflected to right or to left according to the direction of the current. The stronger the current in the coil of wire the greater the deflection of the needle, although after the needle has been deflected to a given point it is not then deflected proportionally as the current strength is increased. By placing beneath the needle a graduated scale, obtained by comparison with a standard galvanometer, the current strength can at once be seen.

Of the two varieties of milliampere meters, the horizontal and the vertical, the former are to be preferred, as the needle of the latter gradually becomes demagnetized and thus will not indicate as strong a current as is actually passing.

In gynecological work a milliampere meter is an absolute necessity in order to protect the patient from injury, for while the patient's sensations may be a sufficient guide to the current strength in percutaneous work, no such guide is furnished by the comparatively insensible mucous membrane lining the vagina and uterus, and as the current is concentrated on a small spot much damage might be wrought by too strong a current.

Several good milliampere meters are manufactured in this country, notably those of McIntosh and of Waite and Bartlett. The meter of McIntosh is provided with two scales, a short and a long one. The short scale registers up to twenty and the long one to one thousand milliamperes. Waite and Bartlett manufacture two meters, one registers up to two hundred and fifty, and the other up to five hundred milliamperes. For use in gynecology a meter registering at least five hundred milliamperes is necessary. For use the meter is included in the circuit between the current controller and the patient.

The conducting cords, to convey the current from the binding posts to the patient, must be of good size, durable and perfectly insulated with braided, not wrapped, covering. The cord tips should be firmly attached to the cords so that there can be no danger of breaking the current.

The electrodes, used in a given case, are two in number, the active and the dispersing electrodes. For the dispersing electrodes, where low intensities, not exceeding seventy-five, or at most one hundred milliamperes, are employed, thin sheet lead is an excellent material as it readily bends to conform to the shape of the abdomen, where it is generally

applied. It should be covered with absorbent cotton which is to be thoroughly moistened before applying to the patient. For intensities over seventy-five or one hundred milliamperes Apostoli's or Goelet's clay electrode becomes necessary. For the active electrode several instruments of various shapes and sizes will be required according to the situation in which they are to be used. All those to be used at the positive pole must be of platinum or heavily plated with gold, to avoid unjustifiable staining of the tissues. Those used at the negative pole can be of brass or copper. It is not necessary to cover the active pole with cotton when used within the vagina or uterus.

Before closing the circuit be sure that all connections between the cells, current controller, meter, binding posts, cords and electrodes are screwed down securely, so that there is no danger of the current becoming broken and your patient receiving a severe shock.